

***Coenogonium hainanense* sp. nov. and new records from China**

XIAO-HAN WU¹, WEI-CHENG WANG^{2,3},
MING-ZHU DOU¹, ZE-FENG JIA^{1*}

¹ College of Life Sciences, Liaocheng University, Liaocheng, China

² State Key Laboratory of Mycology, Institute of Microbiology,
Chinese Academy of Sciences, Beijing 100101, China

³ University of Chinese Academy of Sciences, Beijing 100049, China

* CORRESPONDENCE TO: zfjia2008@163.com

ABSTRACT—A new species, *Coenogonium hainanense*, is proposed, characterized by its small slightly transparent pale yellow to brownish apothecia with plane to concave discs; slightly thick, not prominent, denticulate margins with short dense hairs; and uniseriate or irregularly biseriate, ellipsoid 1-septate ascospores ($10\text{--}11.25 \times 2.5\text{--}3.75$ μm). Eight additional *Coenogonium* species reported as new to China are *C. coronatum*, *C. curvulum*, *C. fallaciosum*, *C. geraldense*, *C. hypophyllum*, *C. moniliforme*, *C. siquirrense*, and *C. usambarense*. Descriptions and distributions of the new species and records are presented, and a key to the 20 *Coenogonium* species known from China is provided.

KEY WORDS—*Coenogoniaceae*, *Lecanoromycetes*, lichens, *Ostropales*, taxonomy

Introduction

Coenogonium Ehrenb. (*Ostropales*: *Coenogoniaceae*), comprising more than 90 species worldwide, has a tropical and subtropical distribution and usually occurs on organic substrata, including bark, bryophytes, and leaves (Baloch & al. 2010, Ferraro & Michlig 2013, Joshi & al. 2015, Lücking & al. 2017, Kantvilas & al. 2018). The genus is characterized by a crustose or filamentous thallus with yellowish, orange, or brown biatorine apothecia and rounded, plane, or concave discs, usually distinct margins, a well-developed excipulum, simple paraphyses, narrowly cylindrical 8-spored asci with thin

TABLE 1. Distributions of *Coenogonium* species previously reported from China.

SPECIES	LOCALITY: REFERENCE
<i>C. dilucidum</i>	GUANGXI & HAINAN: Wu & al. 2018. HONG KONG: Aptroot & Seaward 1999, as <i>Dimerella dilucida</i> ; Aptroot & Sipman 2001, as <i>D. dilucida</i> .
<i>C. disjunctum</i>	TAIWAN: Wu & al. 2018.
<i>C. interplexum</i>	TAIWAN: Wang-Yang 1972; Wang-Yang & Lai 1973; Wu & al. 2018. YUNNAN: Wu & al. 2018.
<i>C. isidiatum</i>	SICHUAN & XIZANG: Obermayer 2004, as <i>D. isidiata</i> .
<i>C. leprieurii</i>	FUJIAN: Zahlbruckner 1930; Wu & al. 2018. YUNNAN: Wu & al. 2018.
<i>C. linkii</i>	GUANGXI & HAINAN: Wu & al. 2018. HONG KONG: Aptroot & Seaward 1999; Seaward & Aptroot 2005, as <i>C. cf. linkii</i> ; Pfister 1978, as <i>C. disjunctum</i> ; Aptroot & Sipman 2001. TAIWAN: Zahlbruckner 1933, as <i>C. subvirescens</i> ; Asahina 1939, as <i>C. boninense</i> ; Wang-Yang 1972; Wang-Yang & Lai 1973; Yoshimura 1974, as <i>C. boninense</i> ; Wu 1987, as <i>C. boninense</i> .
<i>C. luteum</i>	ZHEJIANG: Wu & Qian 1989, <i>D. lutea</i> . ANHUI: Wu & al. 2018. FUJIAN: Zahlbruckner 1930, as <i>Microphiale lutea</i> ; Wu & al. 2018. HUBEI: Chen & al. 1989, as <i>D. lutea</i> . HAINAN: Wu & al. 2018. HONG KONG: Aptroot & Seaward 1999, as <i>D. lutea</i> ; Seaward & Aptroot 2005, as <i>D. lutea</i> ; Pfister 1978, as <i>Gyalecta lutea</i> ; Aptroot & Sipman 2001, as <i>D. lutea</i> .
<i>C. minimum</i>	GUANGXI: Wang & Wei 2018.
<i>C. pineti</i>	HONG KONG: Aptroot & Sipman 2001, as <i>D. pineti</i> . TAIWAN: Aptroot & Sparrius 2003, as <i>D. pineti</i> .
<i>C. subluteum</i>	HONG KONG: Aptroot & Seaward 1999, as <i>D. epiphylla</i> ; Aptroot & Sipman 2001, as <i>D. epiphylla</i> . TAIWAN: Chung 1995, as <i>D. epiphylla</i> ; Aptroot & al. 2003. YUNNAN: Zahlbruckner 1930, as <i>M. brachyspora</i> , <i>M. epiphylla</i> , and <i>M. lutea</i> f. <i>foliicola</i> ; Santesson 1952, as <i>D. epiphylla</i> ; Wei & Jiang 1991; Aptroot & al. 2003; Wu & al. 2018.
<i>C. zonatum</i>	YUNNAN: Aptroot & al. 2003.

walls and unthickened apices lacking internal amyloid structures; typically (0–)1-septate ellipsoid to fusiform hyaline ascospores; the absence of lichen secondary substances; and the presence of a trentepohliod photobiont (Lücking & Kalb 2000, Rivas Plata & al. 2006, Lücking 2008).

Eleven *Coenogonium* species have been reported from China: *C. dilucidum* (Kremp.) Kalb & Lücking, *C. disjunctum* Nyl., *C. interplexum* Nyl., *C. isidiatum* (G. Thor & Vězda) Lücking & al., *C. leprieurii* (Mont.) Nyl., *C. linkii* Ehrenb., *C. luteum* (Dicks.) Kalb & Lücking, *C. minimum* (Müll. Arg.) Lücking, *C. pineti* (Ach.) Lücking & Lumbsch, *C. subluteum* (Rehm) Kalb & Lücking, and *C. zonatum* (Müll. Arg.) Kalb & Lücking (TABLE 1). Our current research on *Coenogonium* revealed one new species and eight species records for China.

Materials & methods

The specimens are deposited in the Herbarium Mycologicum Academiae Sinicae-Lichenes, Beijing, China (HMAS-L), and the Fungarium, College of Life Sciences,

Liaocheng University, China (LCUF). An Olympus SZX16 dissecting microscope and Olympus BX53 light microscope were used for the morphological and anatomical studies. Measurements were taken from manual cross sections of fruit bodies in water. Amyloidity of the ascospores was tested using Lugol's solution. The thallus surface and thin thallus sections were spot tested with 20% KOH. The lichen substances were detected and identified by thin-layer chromatography (Culberson & Kristinsson 1970, Culberson 1972, White & James 1985, Jia & Wei 2016).

Taxonomy

Coenogonium hainanense X.H. Wu & Z.F. Jia, sp. nov.

FIG. 1

FN 570605

Differs from *Coenogonium lisowskii* by its larger apothecia and ascospores.

TYPE: CHINA. HAINAN PROVINCE, Changjiang County, Bawang Ridge, 19°16'N 109°03'E, alt. 700 m, on leaves, 5 Sep. 2008, B. Gao HNF056 (Holotype, HMAS-L 126438).

ETYMOLOGY: The specific epithet refers to the type locality, Hainan Island.

THALLUS crustose, foliicolous, very thin, smooth, pale green to grey green, slightly shiny. APOTHECIA epiphyllous, sessile, rounded, 0.1–0.3 mm

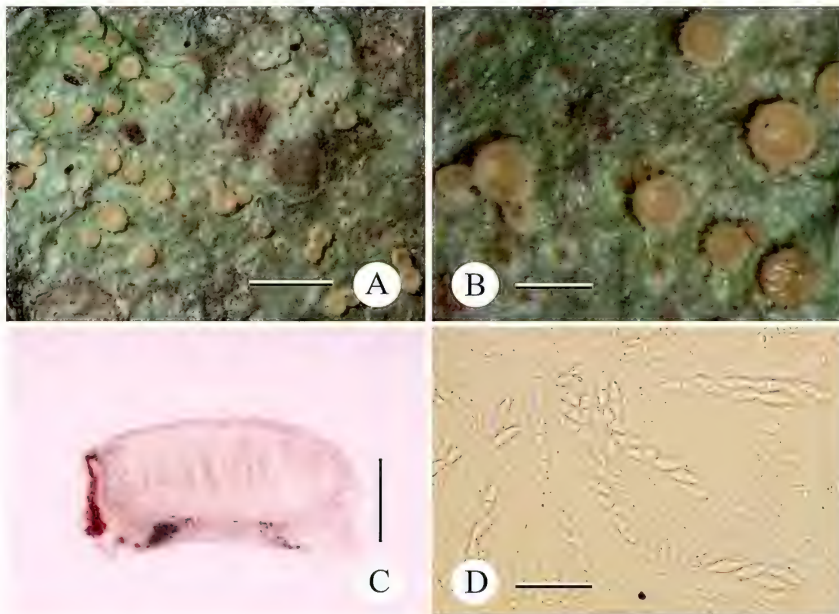


FIG. 1. *Coenogonium hainanense* (holotype, HMAS-L 126438). A. Thallus with apothecia; B. Apothecia; C. Cross section of apothecium; D. Ascus with ascospores. Scale bars: A = 1 mm; B = 0.5 mm; C = 100 µm; D = 20 µm.

diam.; disc plane to concave, pale yellow to brownish, slightly transparent; margin slightly thick, not prominent, denticulate, with short dense hairs of fungal hyphae, wax-colored; EXCIPLE colorless, 20–35 μm broad; HYMENIUM 60–70 μm high, colorless; HYPOTHECIUM 15–20 μm high, colorless to pale brownish. ASCI 8-spored, 50–70 $\times$ 7–9 μm ; ASCOSPORES uniseriate or irregularly biseriate, ellipsoid, 1-septate, 10–11.25 $\times$ 2.5–3.75 μm , 3–4 times as long as broad. PYCNIDIA not observed.

CHEMISTRY: No lichen substances detected by TLC.

ECOLOGY & DISTRIBUTION: On the surface of living leaves in humid, semi-exposed forests of Hainan Island, south China.

REMARKS: *Coenogonium hainanense* is characterized by its small pale yellow to brownish, slightly transparent apothecia with plane to concave discs; slightly thick, not prominent, and denticulate margins covered by short dense hairs; ellipsoid ascospores, 1-septate, 10–11.25 $\times$ 2.5–3.75 μm . The new species is very similar to *C. lisowskii* (Vězda) Lücking and *C. dilucidum*, but *C. lisowskii* has smaller apothecia (0.05–0.15 mm diam.) with smooth hairless margins and smaller ascospores (7–9 $\times$ 1.8–2.5 μm), and *C. dilucidum* has broader ascospores (3.75–5 μm diam.; Lücking 2008).

Coenogonium coronatum G. Neuwirth & Stock.-Wörg.,

Bryologist 117: 161 (2014)

FIG. 2

THALLUS crustose, foliicolous, smooth, yellowish green to pale green. APOTHECIA epiphyllous, sessile, rounded, 0.15–0.35 mm diam.; discs plane (concave in young apothecia), pale yellow to creamy; margins slightly thick, densely pilose, cream-colored, hairs consisting of fungal hyphae. ASCI 8-spored, 35–50 $\times$ 6–8 μm ; ASCOSPORES irregularly biseriate, ellipsoid, 1-septate, 10–12.5 $\times$ 3–3.75 μm , 2.7–3.3 times as long as broad.

SPECIMEN EXAMINED: CHINA. HAINAN PROVINCE, Ledong County, Jianfeng Ridge, Mingfeng Valley, alt. 960 m, 6 Sep. 2017, W.C. Wang HN20170170 (HMAS-L 139527).

ECOLOGY & DISTRIBUTION: On leaves. South-East Asia: Thailand (Neuwirth & al. 2014, Kalb & al. 2016). New record for China.

REMARKS: *Coenogonium coronatum* is characterized by its small and pale-yellow apothecia with concave disc, and slightly thick, densely pilose margin. The species resembles *C. subluteum*, which differs in having cilia on the outer excipulum (Kalb & al. 2016).

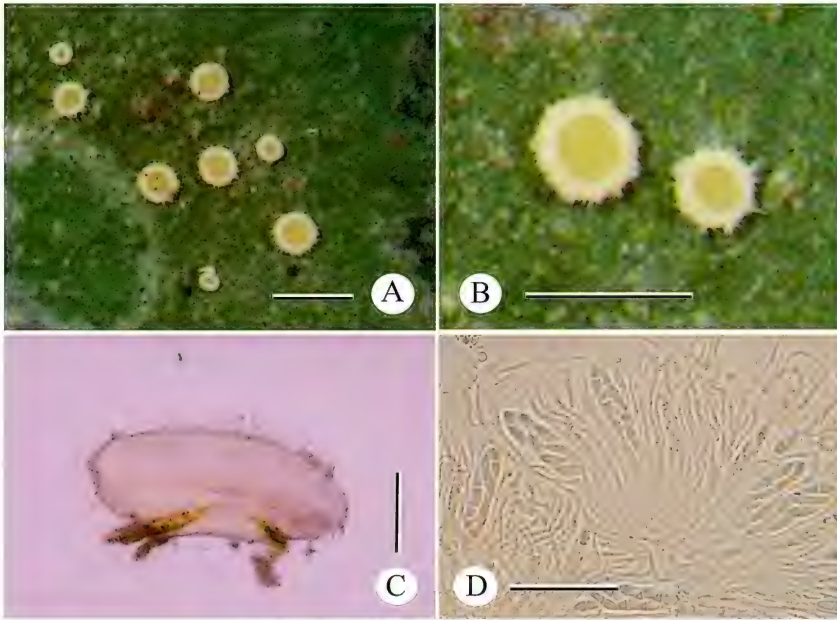


FIG. 2. *Coenogonium coronatum* (HMAS-L 139527). A. Thallus with apothecia; B. Apothecia; C. Cross section of apothecium; D. Ascus with ascospores; Scale bars: A, B = 0.5 mm; C = 100 μ m; D = 50 μ m.

Coenogonium curvulum Zahlbr., Ann. Cryptog. Exot. 1: 164 (1928)

FIG. 3

THALLUS filamentous, foliicolous, green to bright green, forming a thin crust of irregular filaments attached to the substrate from which a short and dense layer of erect filaments emerge. APOTHECIA sessile, rounded, 0.2–0.45 mm diam., immersed in a loose algal carpet, pale yellow to yellow; discs plane to slightly concave; margins glabrous, smooth, cream-colored. ASCI 8-spored; ASCOSPORES curved, colorless, biseriate, ellipsoid, 1-septate, $6.25\text{--}7.5 \times 2.5 \mu\text{m}$, 2.5–3 times as long as broad.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Wuzhishan City, Wuzhishan Tropical Rainforest Scenic Area, alt. 600 m, 9 Sep. 2017, W.C. Wang HN20170360 (HMAS-L 139783); Wuzhishan National Forest Park, alt. 800 m, 8 Sep. 2017, W.C. Wang HN20170335 (HMAS-L 139428); Changjiang County, Bawang Ridge, Baishitan, alt. 700 m, 9 Sep. 2017, W.C. Wang HN20170039 (HMAS-L 139418).

ECOLOGY & DISTRIBUTION: On leaves. Neotropics and eastern Paleotropics: Indonesia (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium curvulum* is characterized by its filamentous, foliicolous thallus with short, upright hair-like algal threads and

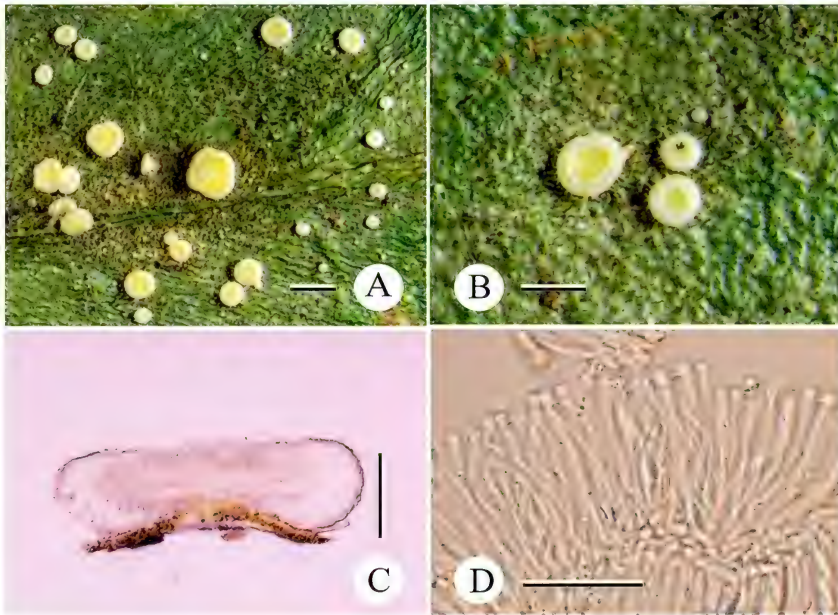


FIG. 3. *Coenogonium curvulum* (HMAS-L 139783). A. Thallus with apothecia; B. Apothecia; C. Cross section of apothecium; D. Ascus with ascospores. Scale bars: A, B = 0.5 mm; C = 100 µm; D = 50 µm.

curved ellipsoid ascospores. It resembles *C. epiphyllum* Vain., which is distinguished by larger (0.3–0.8 mm diam.) apothecia and straight ascospores.

***Coenogonium fallaciosum* (Müll. Arg.) Kalb & Lücking,**

Bot. Jahrb. Syst. 122: 32 (2000)

FIG. 4

THALLUS crustose, foliicolous, pale green to grey green. APOTHECIA mostly marginally hypophyllous on mycelium-free algae, sessile, rounded, 0.3–1(–1.5) mm diam.; disc plane, pale yellow to yellow orange; margin very thin, smooth, concolorous with disc or slightly paler. ASCI 8-spored; ASCOSPORES colorless, uniseriate or irregularly biseriate, ellipsoid, 1-septate, 7–10 × 2.5–3.5 µm, 2.5–3.5 times as long as broad.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Changjiang County, Bawang Ridge, Baishitan, alt. 700 m, 4 Sep. 2017, W.C. Wang HN20170026 (HMAS-L 139458), HN20170031 (HMAS-L 139463), HN20170036 (HMAS-L 139468), HN20170038 (HMAS-L 139470), HN20170042 (HMAS-L 139473); Baoting County, Qixian Ridge National Forest Park, alt. 350 m, 7 Sep. 2017, W.C. Wang HN20170239 (HMAS-L 139553), HN20170274 (HMAS-L 139494), HN20170275 (HMAS-L 139495), HN20170276 (HMAS-L 139496), HN20170277 (HMAS-L 139497), S.H. Jiang

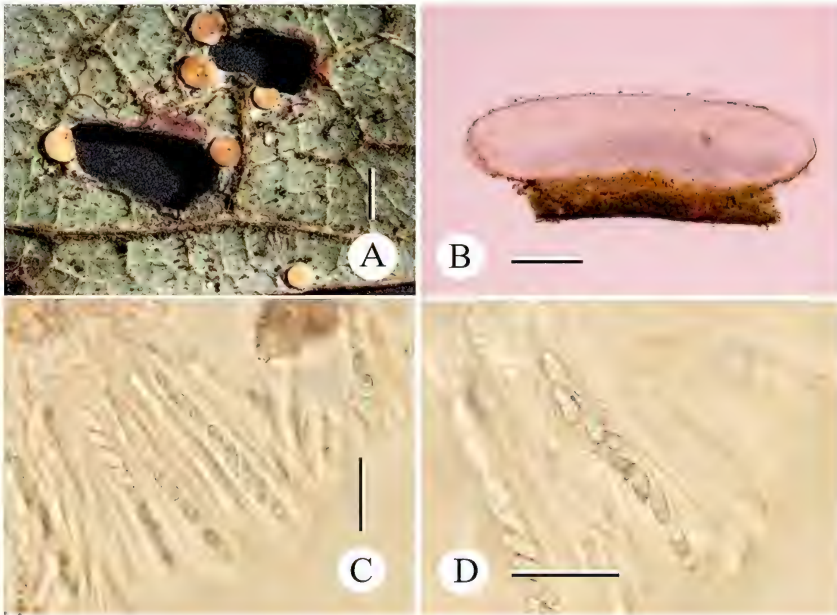


FIG. 4. *Coenogonium fallaciosum* (HMAS-L 139775). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascospores uniseriate D. Ascospores irregularly biseriata. Scale bars : A = 2 mm; B = 100 µm; C, D = 20 µm.

HN20171262 (HMAS-L 144212); Wuzhishan City, Wuzhishan National Forest Park, alt. 800 m, 8 Sep. 2017, W.C. Wang HN20170328 (HMAS-L 139770), HN20170333 (HMAS-L 139775); YUNNAN PROVINCE, Xishuangbanna, Mengla County, Tropical Botanical Garden of Chinese Academy of Sciences, alt. 529 m, 25 Jan 2018, W.C. Wang 20180225 (HMAS-L 144228).

ECOLOGY & DISTRIBUTION: On leaves. Pantropical: Brazil (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium fallaciosum* is characterized by its apothecia mostly marginally hypophyllous on mycelium-free algae and very thin, smooth margins. It resembles *C. geralense*, which differs in smaller apothecia (0.4–1 mm diam.), smaller ascospores ($6.25\text{--}8.75 \times 1.8\text{--}2.5 \mu\text{m}$), and pale yellow to bright yellow (never orange) apothecia (Lücking 2008).

Coenogonium geralense (Henn.) Lücking,
Fl. Neotrop., Monogr. 103: 579 (2008)

FIG. 5

THALLUS crustose, foliicolous, thin, yellowish green to grey green. APOTHECIA epiphyllous or marginally hypophyllous, sessile, rounded,

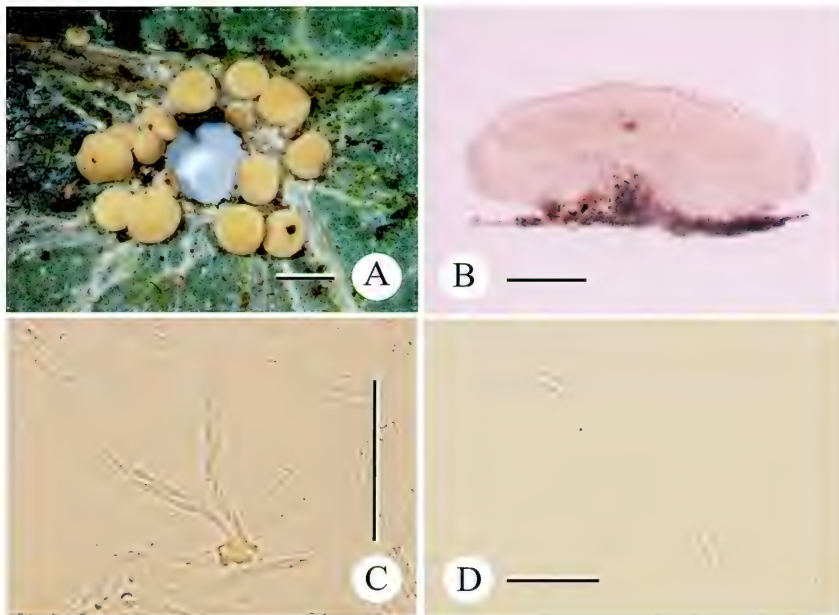


FIG. 5. *Coenogonium geralense* (HMAS-L 144268). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus with ascospores; D. Ascospores. Scale bars: A = 1 mm; B = 100 µm; C = 50 µm; D = 20 µm.

0.4–1 mm diam.; disc plane to concave, pale to bright yellow; margins thin, smooth, concolorous to disc or paler. ASCI 8-spored, $45\text{--}55 \times 6\text{--}7$ µm; ASCOSPORES uniseriate or irregularly biseriate, narrowly ellipsoid, 1-septate, $6.25\text{--}8.75 \times 1.8\text{--}2.5$ µm, 3–4 times as long as broad.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Qiongzong, Mt. Limu, alt. 800 m, 18 Dec. 2000, M.R. Huang 458 (HMAS-L 108841); Lingshui County, Mt. Diaoluo, alt. 1050 m, 14 Sep. 2000, M.R. Huang 337 (HMAS-L 112801); Ledong County, Jianfeng Ridge, Mingfeng Valley, alt. 960 m, 6 Sep. 2017, W.C. Wang HN20170168 (HMAS-L 139525), HN20170169 (HMAS-L 139526), HN20170171 (HMAS-L 139434); YUNNAN PROVINCE, Mengla County, Tropical Botanical Garden of Chinese Academy of Sciences, Greenstone Forest Scenic Area, 614 m alt., 26 Jan. 2018, W.C. Wang 20180236 (HMAS-L 144268).

ECOLOGY & DISTRIBUTION: On leaves. Pantropical: Brazil (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium geralense* is characterized by its crustose, foliicolous, smooth, yellowish green to grey green thallus and ellipsoid,

1-septate ascospores. It is similar to *C. dilucidum*, which is distinguished by larger ascospores ($6\text{--}12 \times 2.5\text{--}3.5\ \mu\text{m}$; Kalb & al. 2016).

Coenogonium hypophyllum (Vězda) Kalb & Lücking,

Bot. Jahrb. Syst. 122: 32 (2000)

FIG. 6

THALLUS crustose, foliicolous, hypophyllous, thin, smooth, pale greenish grey to yellow brownish. APOTHECIA hypophyllous, sessile, rounded, 0.25–0.35 mm diam.; discs plane to concave, pale yellow; margins thin, smooth to minutely dentate, wax-colored. ASCI 8-spored, $45\text{--}60 \times 6\text{--}8\ \mu\text{m}$; ASCOSPORES irregularly biseriate, fusiform, 1-septate, $11.25\text{--}15 \times 2.5\ \mu\text{m}$, 5–6 times as long as broad.

SPECIMEN EXAMINED: CHINA. HAINAN PROVINCE, Ledong County, Jianfeng Ridge, alt. 900 m, 3 Apr. 1993, Y.M. Jiang & S.Y. Guo H-0695 (HMAS-L 138640).

ECOLOGY & DISTRIBUTION: On leaves. Pantropical: Tanzania (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium hypophyllum* is characterized by its foliicolous thallus and regularly hypophyllous apothecia with smooth to minutely

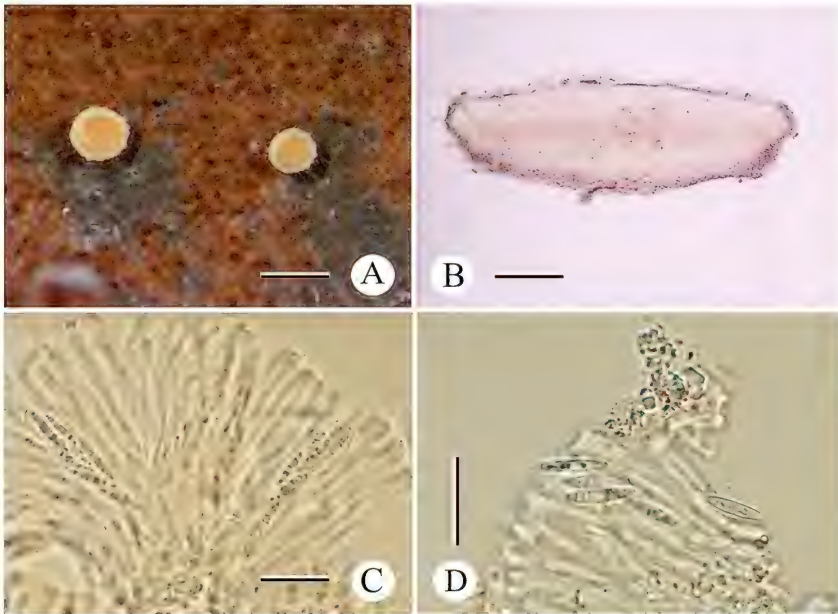


FIG. 6. *Coenogonium hypophyllum* (HMAS-L 138640). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus with ascospores; D. Ascospores. Scale bars: A = 0.5 mm; B = 100 μm ; C, D = 20 μm .

dentate margins. It resembles *C. subzonatum* (Lücking) Lücking & Kalb, which differs in its apothecia marginally hypophyllous on a mycelium free of algae and smaller ascospores ($7\text{--}10 \times 2.5\text{--}3.5\text{ }\mu\text{m}$; Lücking 2008).

Coenogonium moniliforme Tuck., Proc. Amer. Acad. Arts 5: 416 (1862) FIG. 7

THALLUS filamentous with densely woven filaments forming closely appressed mats, moderately thick, pale to dark green or brownish green. APOTHECIA sessile, rounded, 0.2–0.35 mm diam.; discs plane to concave, pale to dark orange; margins thin, smooth, wax-colored. ASCI 8-spored, $45\text{--}55 \times 6\text{--}8\text{ }\mu\text{m}$; ASCOSPORES irregularly biserial, fusiform, 1-septate, $8.75\text{--}11.25 \times 2.5\text{--}3.75\text{ }\mu\text{m}$, 2.3–4.5 times as long as broad.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Ledong County, Jianfeng Ridge, Mingfeng Valley, alt. 960 m, 6 Sep. 2017, W.C. Wang HN20170218 (HMAS-L 139421), S.H. Jiang HN20171048 (HMAS-L 144213).

ECOLOGY & DISTRIBUTION: On leaves. Pantropical: Cuba (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium moniliforme* is characterized by its filamentous thallus with the densely woven filaments forming closely appressed mats and plane to

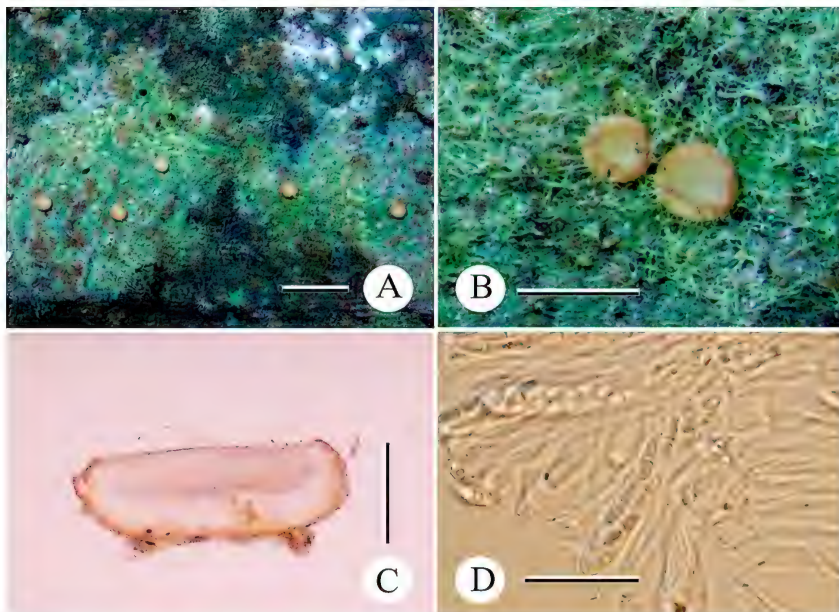


FIG. 7. *Coenogonium moniliforme* (HMAS-L 144213). A. Thallus with apothecia; B. Apothecia; C. Cross section of apothecium; D. Ascus with ascospores. Scale bars: A = 1 mm; B = 0.5 mm; C = 100 μm ; D = 30 μm .

concave, pale to dark orange discs. It closely resembles *C. flavoviride* M. Cáceres & Lücking, which is distinguished by its much smaller ascospores ($4\text{--}6 \times 1.8\text{--}2\text{ }\mu\text{m}$; Lücking 2008).

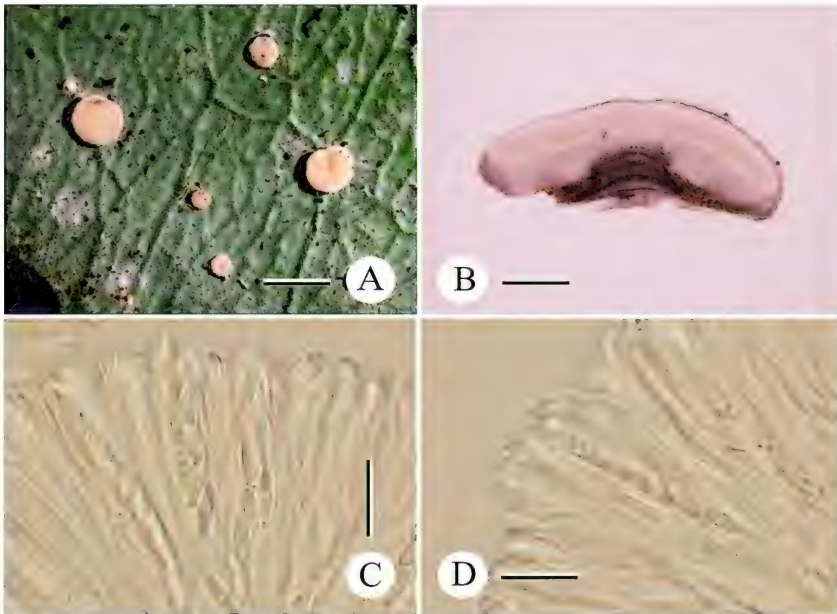


FIG. 8. *Coenogonium siquirrense* (HMAS-L 139552). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascospores irregularly biseriate; D. Ascospores uniseriate. Scale bars: A = 1 mm; B = 100 μm ; C, D = 20 μm .

***Coenogonium siquirrense* (Lücking) Lücking,**

Fl. Neotrop., Monogr. 103: 580 (2008)

FIG. 8

THALLUS crustose, foliicolous, continuous, thin, smooth, green to dark green. APOTHECIA mostly epiphyllous, sessile, rounded, 0.5–0.8 mm diam.; discs plane, orange with darker marginal zone and paler centre; margins thin, smooth, pale orange. ASCI 8-spored, $30\text{--}45 \times 3\text{--}4\text{ }\mu\text{m}$; ASCOSPORES uniseriate or irregularly biseriate, narrowly ellipsoid, 1-septate, $7.5\text{--}10 \times 2\text{--}2.5\text{ }\mu\text{m}$, 3–4 times as long as broad.

SPECIMEN EXAMINED: CHINA. HAINAN PROVINCE, Baoting County, Qixian Ridge National Forest Park, 350 m alt., 7 Sep. 2017, W.C. Wang HN20170238 (HMAS-L 139552).

ECOLOGY & DISTRIBUTION: On leaves. Neotropics: Costa Rica (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium siquirrense* is characterized by its crustose, foliicolous thallus, mostly epiphyllous sessile 0.5–0.8 mm diam. apothecia, and narrowly ellipsoid ascospores. The closely similar *C. geralense* differs in its pale to bright yellow often marginally hypophyllous apothecia with plane to concave discs (Lücking 2008). The also similar *C. luteum* is distinguished by its larger (0.5–2 mm diam.), more prominent apothecia and broader ascospores (2.5–3.75 µm diam.; Lücking 2008).

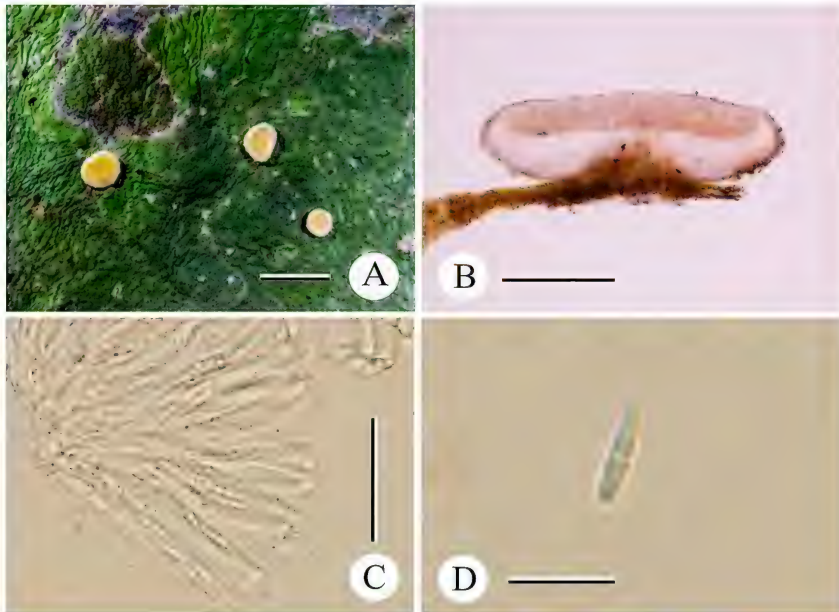


FIG. 9. *Coenogonium usambarense* (HMAS-L 139777). A. Thallus with apothecia; B. Cross section of apothecium; C. Ascus with ascospores; D. Ascospores. Scale bars: A = 2 mm; B = 200 µm; C = 50 µm, D = 10 µm.

Coenogonium usambarense (Vězda & Farkas) Lücking & Kalb,
Biblioth. Lichenol. 78: 255 (2001)

FIG. 9

THALLUS crustose, foliicolous, epiphyllous, thin, smooth, green to bright green. APOTHECIA sessile, rounded, 0.4–0.8 mm diam.; discs plane to slightly convex, pale yellow to orange; margins smooth, cream-colored. ASCI 8-spored, 40–45 × 4–6 µm; ASCOSPORES irregularly biseriate, ellipsoid, 1-septate, 8.5–11.25 × 2.5–3 µm, 4–5 times long as broad.

SPECIMENS EXAMINED: CHINA. HAINAN PROVINCE, Wuzhishan City, Wuzhishan National Forest Park, 800 m alt., 8 Sep. 2017, W.C. Wang HN20170336 (HMAS-L

139777); YUNNAN PROVINCE, Mengla County, Tropical Botanical Garden of Chinese Academy of Sciences, 549 m alt., 25 Jan. 2018, X.H. Wu YN18082 (LCU); Greenstone Forest Scenic Area, Dabangen, 672 m alt., 26 Jan. 2018, X.H. Wu YN18160 (LCU).

ECOLOGY & DISTRIBUTION: On leaves. African and eastern Paleotropics: Tanzania (Rivas Plata & al. 2006). New record for China.

REMARKS: *Coenogonium usambarens* is characterized by a crustose, foliicolous, epiphyllous, thin, smooth, and green or bright green thallus and ellipsoid ascospores ($8.5\text{--}11.25 \times 2.5\text{--}3 \mu\text{m}$). The similar *C. epiphyllum* produces much shorter and broader ascospores ($6\text{--}8 \times 2.5\text{--}3.75 \mu\text{m}$; Vězda & Farkas 1988).

Key to all the known species of *Coenogonium* in China

1. Thallus filamentous 2
1. Thallus crustose 7
2. Thallus distinctly filamentous, in loose, erect mats or
horizontally projecting, shelf-like structures 3
2. Thallus indistinctly filamentous, in thin densely woven mats or
with well-developed upright short filaments 6
3. Ascospores simple, $5\text{--}8 \times 2\text{--}3 \mu\text{m}$ *C. lepreurii*
3. Ascospores 1-septate 4
4. Thallus dimidiate or shelf-like; ascospores $6\text{--}9 \times 2\text{--}3 \mu\text{m}$ *C. linkii*
4. Thallus prostrate, irregularly woven 5
5. Ascospores $7\text{--}10 \times 2\text{--}3 \mu\text{m}$ *C. interplexum*
5. Ascospores $10\text{--}14 \times 2.5 \mu\text{m}$ *C. disjunctum*
6. Ascospores $8.75\text{--}11.25 \times 2.5\text{--}3.75 \mu\text{m}$ *C. moniliforme*
6. Ascospores $6.75\text{--}7.5 \times 2.5 \mu\text{m}$ *C. curvulum*
7. Thallus with isidia; ascospores $9\text{--}14 \times 3\text{--}4 \mu\text{m}$ *C. isidiatum*
7. Thallus lacking isidia 8
8. Thallus and apothecia regularly hypophyllous;
ascospores $11.25\text{--}15 \times 2.5 \mu\text{m}$, fusiform *C. hypophyllum*
8. Thallus and apothecia epiphyllous or apothecia often marginally hypophyllous ... 9
9. Apothecia very small, $0.1\text{--}0.25 \text{ mm}$ 10
9. Apothecia larger, $0.25\text{--}2 \text{ mm}$ 11
10. Apothecia light brown to yellow brown with strongly concave discs
and thick margins; ascospores $10\text{--}14 \times 3\text{--}4 \mu\text{m}$ *C. minimum*
10. Apothecia wax-colored to pale yellow with flat to slightly concave discs;
ascospores $10\text{--}12.5 \times 3.75\text{--}5 \mu\text{m}$ *C. dilucidum*
11. Apothecia margin densely pilose or slightly denticulate 12
11. Apothecia margin smooth 13

12. Apothecia pale yellow to creamy, margins cream-colored,
densely pilose (sometimes abraded in older apothecia);
ascospores $10\text{--}12.5 \times 3\text{--}3.75 \mu\text{m}$ *C. coronatum*
12. Apothecia pale yellow to brownish, slightly transparent,
margins denticulate; ascospores $10\text{--}11.25 \times 2.5\text{--}3.75 \mu\text{m}$ *C. hainanense*
13. Ascospores narrowly ellipsoid to oblong ($1.8\text{--}2.5 \mu\text{m}$ broad),
usually irregularly biseriate 14
13. Ascospores broadly ellipsoid ($2.5\text{--}5 \mu\text{m}$ broad), usually uniseriate 15
14. Apothecia pale to bright yellow with pale margins;
ascospores $6.25\text{--}8.75 \times 1.8\text{--}2.5 \mu\text{m}$ *C. geraldense*
14. Apothecia orange with darker marginal zones and paler centres;
ascospores $7.5\text{--}10 \times 2\text{--}2.5 \mu\text{m}$ *C. siquirrense*
15. Apothecia 1–2 mm, bright yellow to yellow orange;
ascospores $7.5\text{--}8.75 \times 2.5\text{--}3.75 \mu\text{m}$ *C. luteum*
15. Apothecia 0.25–1 mm, wax-colored to pale orange 16
16. Apothecia usually marginally hypophyllous, 0.3–1(–1.5) mm, pale yellow
to yellow orange; margins very thin, smooth, concolorous with disc
or slightly paler; ascospores $7\text{--}10 \times 2.5\text{--}3.5 \mu\text{m}$ *C. fallaciosum*
16. Apothecia usually epiphyllous 17
17. Apothecia wax-colored to pale orange 18
17. Apothecia white to pale yellow or orange 19
18. Prothallus present, white; ascospores $7.5\text{--}10 \times 2.5\text{--}4 \mu\text{m}$ *C. zonatum*
18. Prothallus absent; ascospores $10\text{--}12.5 \times 2.5\text{--}3.75 \mu\text{m}$ *C. subluteum*
19. Apothecia white to pinkish (rarely orange tinged), 0.2–0.5 mm,
margins smooth; ascospores $9\text{--}14 \times 2.3\text{--}4.5 \mu\text{m}$ *C. pineti*
19. Apothecia pale yellow to orange, margins smooth, cream-colored;
ascospores $8.5\text{--}11.25 \times 2.5\text{--}3 \mu\text{m}$ *C. usambarensis*

Acknowledgments

This study was supported by the National Natural Science Foundation of China (31750001, 31270066 & 31470149). The authors are grateful to the presubmission reviewers Dr. Wei Xin-li (State Key Laboratory of Mycology, Institute of Microbiology, Chinese Academy of Sciences, Beijing) and Prof. Qiang Ren (College of Life Sciences, Shandong Normal University, China) for reading and improving the manuscript.

Literature cited

- Aptroot A, Seaward MRD. 1999. Annotated checklist of Hong Kong lichens. *Tropical Bryology* 17: 57–101.
- Aptroot A, Sipman HJM. 2001. New Hong Kong lichens, ascomycetes and lichenicolous fungi. *Journal of the Hattori Botanical Laboratory* 158(91): 317–343.
- Aptroot A, Sparrius LB. 2003. New microlichens from Taiwan. *Fungal Diversity* 14: 1–50.

- Aptroot A, Ferraro LI, Lai MJ, Sipman HJM, Sparrius LB. 2003. Foliicolous lichens and their lichenicolous ascomycetes from Yunnan and Taiwan. *Mycotaxon* 88: 41–47.
- Asahina Y. 1939. *Nippon Inkwasayokubutu Dukan* (Illustrated Flora of Japanese Cryptogams). Sansido, Tokyo. 713 p.
- Baloch E, Lücking R, Lumbsch HT, Wedin M. 2010. Major clades and phylogenetic relationships between lichenized and non-lichenized lineages in *Ostropales* (Ascomycota: Lecanoromycetes). *Taxon* 59(5): 1483–1494. <https://doi.org/10.2307/20774043>
- Chen JB, Wu JN, Wei JC. 1989. *Fungi and lichens of Shennongjia*. World Book Inc, Beijing. 386–493.
- Chung CH. 1995. Notes on some foliicolous lichenized fungi from Taiwan. *Taiwania* 40(2): 151–155.
- Culberson CF. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. *Journal of Chromatography* 72: 113–125. [https://doi.org/10.1016/0021-9673\(72\)80013-X](https://doi.org/10.1016/0021-9673(72)80013-X)
- Culberson CF, Kristinsson H. 1970. A standardized method for the identification of lichen products. *Journal of Chromatography* 46: 85–93. [http://doi.org/10.1016/S0021-9673\(00\)83967-9](http://doi.org/10.1016/S0021-9673(00)83967-9)
- Ferraro LI, Michlig A. 2013. New species and additional records of *Coenogonium* (Ostropales: Coenogoniaceae) from southern South America. *Lichenologist* 45(4): 497–504. <https://doi.org/10.1017/s0024282913000169>
- Jia ZF, Wei JC. 2016. *Flora Lichenum Sinicorum*, vol. 13. – *Ostropales* (I) – *Graphidaceae* 1. Science Press, Beijing. 210 p. (in Chinese)
- Joshi Y, Gagarina L, Halda JP, Oh SO, Hur JS. 2015. A new species and a new record of the lichen genus *Coenogonium* (Ostropales: Coenogoniaceae) from South Korea, with a world-wide key to crustose *Coenogonium* having prothalli. *Mycosphere* 6(6): 667–672. <https://doi.org/10.5943/mycosphere/6/6/3>
- Kalb J, Boonpragob K, Kalb K. 2016. New *Coenogonium* species (Ostropales: Coenogoniaceae) from Thailand, new reports and a revised key to the species occurring in the country. *Phytotaxa* 283(2): 101. <https://doi.org/10.11646/phytotaxa.283.2.1>
- Kantvilas G, Rivas Plata E, Lücking R. 2018. The lichen genus *Coenogonium* in Tasmania. *Lichenologist* 50(5): 571–582. <https://doi.org/10.1017/s0024282918000385>
- Lücking R. 2008. Foliicolous lichenized fungi. *Flora Neotropica Monographs* 103. 866 p.
- Lücking R, Kalb K. 2000. Foliikole Flechten aus Brasilien (vornehmlich Amazonien), inklusive einer Checkliste und Bemerkungen zu *Coenogonium* und *Dimerella* (Gyalectaceae). *Botanische Jahrbücher für Systematik* 122(1): 1–61.
- Lücking R, Hodkinson B P, Leavitt S D. 2017. The 2016 classification of lichenized fungi in the Ascomycota and Basidiomycota – approaching one thousand genera. *Bryologist* 119(4): 361–416. <https://doi.org/10.1639/0007-2745-119.4.361>
- Neuwirth G, Stocker-Wörgötter E, Boonpragob K, Saipunkaew W. 2014. *Coenogonium coronatum* (Ostropales: Coenogoniaceae), a new foliicolous species from Thailand, ecological aspects and a key to the species occurring in the country. *Bryologist* 117: 161–164. <https://doi.org/10.1639/0007-2745-117.2.161>
- Obermayer W. 2004. Additions to the lichen flora of the Tibetan region. *Bibliotheca Lichenologica* 88: 479–526.
- Pfister DH (ed.). 1978. Lichens by Edward Tuckerman, 65–126, in: *Cryptogams of the United States North Pacific Exploring Expedition, 1853–1856*. Farlow Reference Library & Herbarium of Cryptogamic Botany, Harvard University, Cambridge, MA.

- Rivas Plata E, Lücking R, Aptroot A, & al. 2006. A first assessment of the Ticolichen biodiversity inventory in Costa Rica: The genus *Coenogonium* (*Ostropales: Coenogoniaceae*), with a world-wide key and checklist and a phenotype-based cladistic analysis. *Fungal Diversity* 23(2): 255–321.
- Santesson R. 1952. Follicolous lichens I. A revision of the taxonomy of the obligately follicolous, lichenized fungi. *Symbolae Botanicae Upsalienses* 12(1). 590 p.
- Seaward RD, Aptroot A. 2005. Hong Kong lichens collected on the United States North Pacific exploring expedition, 1853–1856. *Bryologist* 108(2): 282–286. [https://doi.org/10.1639/0007-2745\(2005\)108\[0282:HKLCOT\]2.0.CO;2](https://doi.org/10.1639/0007-2745(2005)108[0282:HKLCOT]2.0.CO;2)
- Vězda A, Farkas E. 1988. Neue follicole Arten der Flechtengattung *Dimerella* Trevisan (*Gyalectaceae*) aus Tansania. *Folia Geobot Phytotaxon* 23(2): 187–197. <https://doi.org/10.1007/bf02853348>
- Wang WC, Wei JC. 2018. *Arthonia*, *Byssoloma*, *Calenia*, *Chroodiscus*, *Coenogonium*, *Eremothecella*, and *Semigyalecta* spp. new to China. *Mycotaxon* 133: 487–497. <https://doi.org/10.5248/133.487>
- Wang-Yang JR. 1972. The taxonomic status of *Coenogonium subvirescens* and *C. interplexum* newly found in Taiwan. *Taiwania* 17(1): 40–47.
- Wang-Yang JR, Lai MJ. 1973. A checklist of the lichens of Taiwan. *Taiwania* 18(1): 83–104. <https://doi.org/10.6165/tai.1973.18.83>
- Wei JC, Jiang YM. 1991. Some follicolous lichens in Xishuangbanna, China. 201–216, in: DJ Galloway (ed.). *Tropical lichens: their systematics, conservation and ecology*, Systematics Association Special Volume no. 43. Clarendon Press, Oxford.
- White FJ, James PW. 1985. A new guide to microchemical techniques for the identification of lichen substances. *British Lichen Society Bulletin* 57: 1–41.
- Wu JL. 1987. Lichen iconography of China. China's Prospect Publishing House, Beijing. 48p. (in Chinese)
- Wu JN, Qian ZG. 1989. Lichens. 182, in: BS Xu (ed.). *Cryptogamic flora of the Yangtze Delta and adjacent regions*. Shanghai Scientific & Technical Publishers, Shanghai. (in Chinese)
- Wu XH, Liu FY, Zhao X, Jia ZF. 2018. A preliminary study on the lichen genus *Coenogonium* from China. *Journal of Tropical and Subtropical Botany* 26(4): 421–428. <http://jtsb.scib.ac.cn/html/2018/4/3880.htm>
- Yoshimura I. 1974. Lichen flora of Japan in colour. Hoikusha Publishing Co., Ltd. 349 p. (in Japanese)
- Zahlbruckner A. 1930. Lichenes. *Symbolae Sinicae* 3. 254 p.
- Zahlbruckner A. 1933. Flechten der Insel Formosa. *Repertorium Novarum Specierum Regni Vegetabilis* 33: 22–68. <https://doi.org/10.1002/fedr.19330330103>